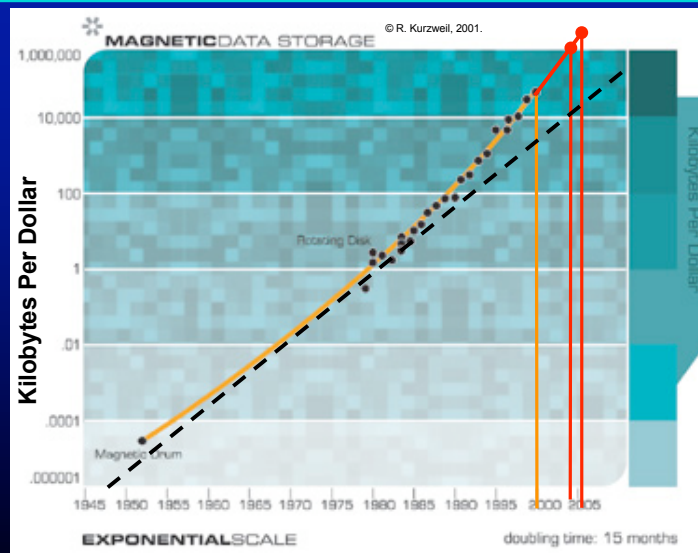# Raging Incrementalism

Rethinking Systems Engineering as if Results Mattered

Michael M. Gorlick
The Aerospace Corporation
El Segundo, California
gorlick@aero.org

THE AEROSPACE CORPORATION

1

Hyperexponential Change

© R. Kurzweil, 2001.

THE AEROSPACE CORPORATION

2

Hyperexponential Change

- Rate of change of change
  - Exponential improvement
  - Doubling periods
  - Technical progress in-the-large
  - By 2025 100 years of progress
  - By 2101 20,000 years of progress
- Hyperexponential change changes everything
  - Everything you knew yesterday is wrong today
  - The system that you haven't built yet is obsolete
  - The integrator is king

3

A Powerful Disturbance in the Force

Legend:
- Clock Speed (MHz)
- Transistors (000)

4
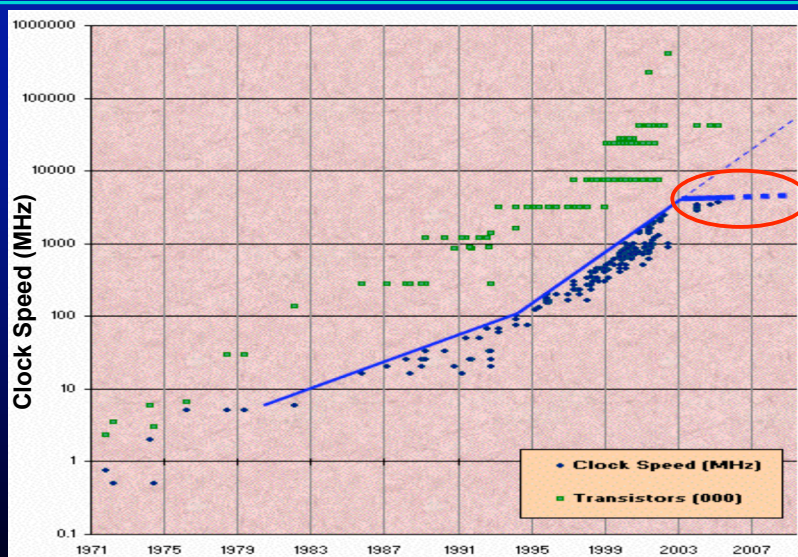
"Think Different" — Think Parallel

- Clock speeds are stalled
  - Intel announces dual-core Pentium
  - IBM announces multi-core Cell processor
- Yet price/performance improves on schedule
  - Processors may not be faster but they are cheaper!
- "When the going gets tough the tough get going"
  - The free ride is over
- Parallel processing is the next frontier
- This looks like a job for *raging incrementalism*

THE AEROSPACE CORPORATION

5

The Zen of Raging Incrementalism

- Surf the tsunami of change
  - Commodity hardware
  - Open-source software
  - Peer-to-peer/Representational State Transfer
- Primary
  - Eschew superfluage
  - Write nothing
  - Buy nothing
  - Integrate everything
- Secondary
  - Always obsolete
  - Never finished
  - A few weeks is forever
  - Computation is free
  - The better is the enemy of the good enough

THE AEROSPACE CORPORATION

6

Go With the Flow

- Coarse-grain data flow
  - Satellite telemetry
  - Multimedia
  - Event distribution
  - Process control
  - Global weather prediction
- Information equivalent of the assembly line
- Parallelism for free
- Adaptive

7
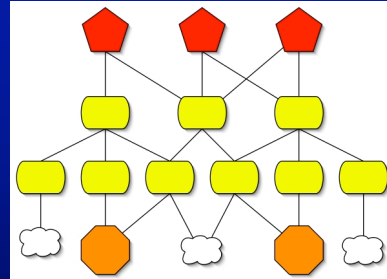
Launch Range Video System

- Video camera brick
  - Shuttle PC & Firewire camera
  - Network camera control
  - Software-based MPEG-4 encoding
  - Digital video streaming
- Proxy brick
  - Protocol translation between camera and streaming bricks
- Video streaming brick
  - Based on Darwin Streaming Server
- Video archive brick
  - 4U commodity rack server with 4 terabytes of storage
  - FreeBSD

- Built in 6 weeks (1 full-time + 1 part-time)
- All bricks constructed and tested in parallel
- Flow everywhere

8

4
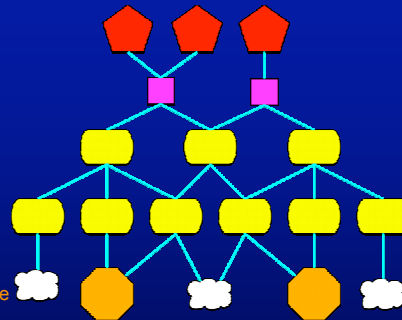
Faster, Better, Cheaper (Choose any Three)

- Faster
  - Build in weeks to months not years
  - Deploy as you build
- Better—meets or exceeds range requirements
  - 320 x 240 full color video at 15 frames per second
  - Modern standards-compliant video compression
  - Scales to hundreds of cameras
  - Remote network control of all cameras
  - Arbitrary video switching
    » All cameras anywhere to anyone at anytime
  - Arbitrary video clients
    » Large-scale video archive for pennies
- Cheaper
  - Low initial investment (< $10K)
  - Incremental upgrade for components and software
  - Reduced operating and maintenance costs

THE AEROSPACE CORPORATION
9

Use the (Open) Source, Luke

- *Linux* and *FreeBSD*
- *libdc1394* for Firewire camera driver
- *spook* for camera control and unicasting
- *xvid* MPEG-4 codec
- *live.com* RTP/RTSP library for proxy protocols
- *Darwin Streaming Server*
- *mencoder* for generating video archive files
- *MySQL* for video archive metadata
- *mplayer* for video playback on desktops

THE AEROSPACE CORPORATION
10

Summary

- Architecture rules
  - Peering constructions decouple components
  - Flow is parallel and scales naturally
- Open-source rules
  - Transparency
  - The power of the creative commons
- Integration rules
  - Proxy brick required *120* lines of custom software
  - Video archive brick required *370* lines of custom software
- Change rules
  - *Raging incrementalism* is a force multiplier

THE AEROSPACE
CORPORATION

11